U. S. ARMY TEST AND EVALUATION COMMAND
COMMODITY ENGINEERING TEST PROCEDURE

INTERCOMMUNICATION SETS

1. OBJECTIVE

The objective of this materiel test procedure is to describe the engineering tests required to determine the technical performance, engineering adequacy, and technical characteristics of intercommunication sets relative to the criteria cited in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other applicable documentation, and determining their suitability for army applications.

2. BACKGROUND

Coordination of operations within a tactical complex such as a command post or a signal installation is generally facilitated by the use of a voice intercommunication system separate and distinct from the common-user telephone system. Intercommunication systems employed for the sole purpose of linking several shelters or offices vary in configuration and operational features dependent upon specific requirements. A basic system may be described as a multi-station discrete wire network employing station instruments (sets) of the distant-talking/listening type operated on a push-to-talk, voice-signaling basis; intermediate equipment is not required. More elaborate systems may consist of a combination of master and subordinate stations with station selection, visual-aural signaling, or privacy features.

Voice communication between stations generally is accomplished on a simplex or one-way reversible basis, i. e. all stations in a network normally are in a listening or receiving condition and users transmit (speak) alternately while operating a press-to-talk switch on their respective sets. The speech transducer of each station set may be (1) a separate microphone and loudspeaker, (2) a single unit functioning as the microphone for transmission and the loudspeaker for reception, or (3) the transmitter and earpiece of a telephone-type handset or headset. The combination microphone-loudspeaker unit is the most common arrangement in that it eliminates the necessity for a hand-held, close-talking instrument. However, a handset may be included in certain set designs to permit occasional private conversations or a comparable headset to provide convenience in long periods of use. Necessary signal amplification in either direction of transmission is provided by an integral audio amplifier which is reversible under control of the press-to-talk switch.

Intercommunication sets designed for use in multi-line, selective-station systems incorporate station/channel selection keys and signaling devices.

Engineering tests of prototype intercommunication sets are required to determine the technical performance and safety characteristics of the item and the suitability for service testing.

3. REQUIRED EQUIPMENT

a. Electronic laboratory
b. Anechoic chamber or equivalent free-field room
c. "Quiet" rooms or tactical environments
d. Signal function generators or audio oscillators
e. Frequency meter/electronic counter
f. Sound level meters
g. Distortion analyzer
h. Sound source transducer
i. Voltmeters, (dbm) - VTVM
j. Multimeter
k. Magnetic tape recorder/reproducers

4. REFERENCES

A. MIL-STD-462(-), Electromagnetic Interference Characteristics, Measurement of
B. TM 11-486, Electrical Communication Systems Engineering
C. Applicable TM's on current standard intercommunication sets.
D. American Standard Acoustical Terminology, S1.1 - 1960, American Standards Association, Inc., May 1960
E. Standard Definitions of Terms for Audio and Electroacoustics, IEEE No. 151. February 1965
F. American Standard Procedures for Calibration of Electroacoustic Transducers, Z24.24-1957, American Standards Association, Inc., December 1957
G. American Standard Method for the Free-field Secondary Calibration of Microphones, Z24.11-1954, American Standards Association, Inc., October 1954
H. IRE Recommended Practices on Audio and Electroacoustics: Loudspeaker Measurements, 1961, IRE Proceedings, Vol. 49, No. 10, October 1961
I. USA Standard Specification for General-Purpose Sound Level Meters, S1.4-1961, U. S. A. Standards Institute, January 1961
J. American Standard Preferred Frequencies for Acoustical Measurements, S1.6-1960, American Standards Association, Inc., January 1960
K. American Standard Method for Measurement of Monosyllabic Word Intelligibility, S3.2-1960, American Standards Association, Inc., May 1960
L. Intelligibility Test Methods and Procedures for the Evaluation of Speech Communication Systems, Bolt, Beranek and Newman, Inc., December 1966, (AD 646-781)
M. Olson, H. F., Acoustical Engineering, D. Van Nostrand, 1957
N. MIL-STD-454A, General Requirements for Electronic Equipment
O. MTP 3-1-002, Confidence Intervals and Sample Size
P. MTP 6-2-110, Handset, Telephone
Q. MTP 6-2-115, Headsets
R. MTP 6-2-507, Safety

5. SCOPE

5.1 SUMMARY

5.1.1 Technical Characteristics

This MTP describes the principal engineering tests required to determine the degree to which intercommunication sets designed specifically for Army use or commercial sets under consideration for Army procurement meet military requirements as expressed in applicable QMR, SDR, TC, or other appropriate documents. The cumulative test results, together with the results of appropriate common engineering tests, will permit an estimate to be made of the technical performance and safety characteristics of the item and the suitability for service testing.

The specific test to be performed, test conditions, and objectives are listed below:

a. Electroacoustic Characteristics-The objective of this test is to determine (1) the electrical response of the test item to a controlled sound field when in the transmitting condition and (2) the acoustical response (sound field characteristics) to controlled electrical signals when in the receiving condition. Subtests include amplitude response, frequency response, directivity and distortion characteristics.

b. Intelligibility Test-The objective of this test is to determine the speech transmission quality of the test item by means of a standard Monosyllabic Word Intelligibility Method wherein "talker" and "listener" personnel employ phonetically-balanced words in speech transmissions over a two-station intercommunication setup located in acoustically representative environments. Speech transmission quality of the test item is graded on the basis of correctly understood words.

c. Miscellaneous Tests-The objective of these tests is to evaluate those features generally found in multi-station intercommunication sets and tests of non-transmission characteristics. These include: signaling, crosstalk, vibration, and electromagnetic interference tests.

5.1.2 Common Engineering Tests

The following Common Engineering Tests, applicable to these commodities, are not included in this MTP:

a. 6-2-500, Physical Characteristics
b. 6-2-502, Human Factors
c. 6-2-504, Design for Maintainability
d. 6-2-514, Power Requirements
e. 6-2-530, Altitude and Temperature Altitude Test
f. 6-2-531, Temperature Test

g. 6-2-532, Sunshine Test
h. 6-2-533, Rain Test
i. 6-2-534, Humidity Test
j. 6-2-535, Fungus Test
k. 6-2-536, Salt Fog Test
l. 6-2-537, Dust Test
m. 6-2-538, Explosive Atmosphere Test
n. 6-2-539, Immersion Test
o. 6-2-540, Vibration Test
p. 6-2-541, Shock Test

5.2 LIMITATIONS

This document excludes consideration of the following:

a. Special items designated as "intercommunication sets" which are integral or ancillary components of vehicular (tank, aircraft) radio-interphone systems or ground-based air traffic control center systems.

b. Intercommunication features of common-user telephone systems. Items in these categories shall be evaluated on a system basis in accordance with applicable procedures.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Select test equipment ideally having an accuracy of at least ten orders of magnitude greater than that afforded by the item under test, that is in keeping with the state of the art, and whose calibration is certified in accordance with Department of the Army Regulations to assure traceability to the National Bureau of Standards.

b. Record the following information:

1) Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.
2) Nomenclature, serial number, accuracy tolerance, calibration requirements, and last date calibrated of the test equipment selected for the tests.

c. Ensure that all test personnel are familiar with the required technical and operational characteristics of the item under test, such as stipulated in Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), and Technical Characteristics (TC).

d. Review all instructional material issued with the test item by the manufacturer, contractor, or government, as well as reports of previous tests conducted on the same types of equipment, and familiarize all test personnel with the contents of such documents. These documents shall be kept readily available for reference.

e. Prepare record forms for systematic entry of data, chronology of test, and analysis in final evaluation of the test item.

f. Prepare adequate safety precautions to provide safety for personnel and equipment, and ensure that all safety SOP's are observed throughout the test and that the item has successfuly completed MTP 6-2-507, Safety and complies with MIL-STD-454 A.

g. Thoroughly inspect the test item for obvious physical and electrical defects such as cracked or broken parts, loose connections, bare or broken wires, loose assemblies, bent fragile parts, and corroded plugs and jacks. All defects shall be noted and corrected before proceeding with the test.

h. Prior to beginning any subtest, verify correct power source, necessary test instrumentation and inter-connection cabling, and that the equipment is aligned, if necessary, as specified in the pertinent operating instructions to ensure, insofar as possible, it represents an average equipment in normal operating condition.

i. Prepare a test item sample plan sufficient to ensure that enough samples of all measurements are taken to provide statistical confidence of final data in accordance with MTP 3-1-002. Provisions shall be made for modification during test progress as may be indicated by monitored test results.

j. Ensure that arrangements for supporting and participating agencies, activities and facilities have been made and that all test personnel have been thoroughly briefed on the purposes of the test and the results expected.

6.2 TEST CONDUCT

NOTE: Modification of these procedures shall be made as required by technical design of the item under test and availability of test equipment, but only to the extent that such modified procedures will not affect the validity of the test results.

6.2.1 Electroacoustic Characteristics

6.2.1.1 Transmitting Tests

a. Arrange the item under test, sound source, and calibrating microphone (P/O SLM) in an anechoic chamber and connect a signal generator, frequency meter, two AC voltmeters, a distortion analyzer, and a sound level meter as shown in Figure 1.

NOTES: 1. The test item shall be placed in the approximate center of the chamber on a vibration-absorbent mount which is movable in the horizontal and vertical planes to permit orienting the test item principal axis with respect to the sound source and measuring microphone. (See Figure A-2)

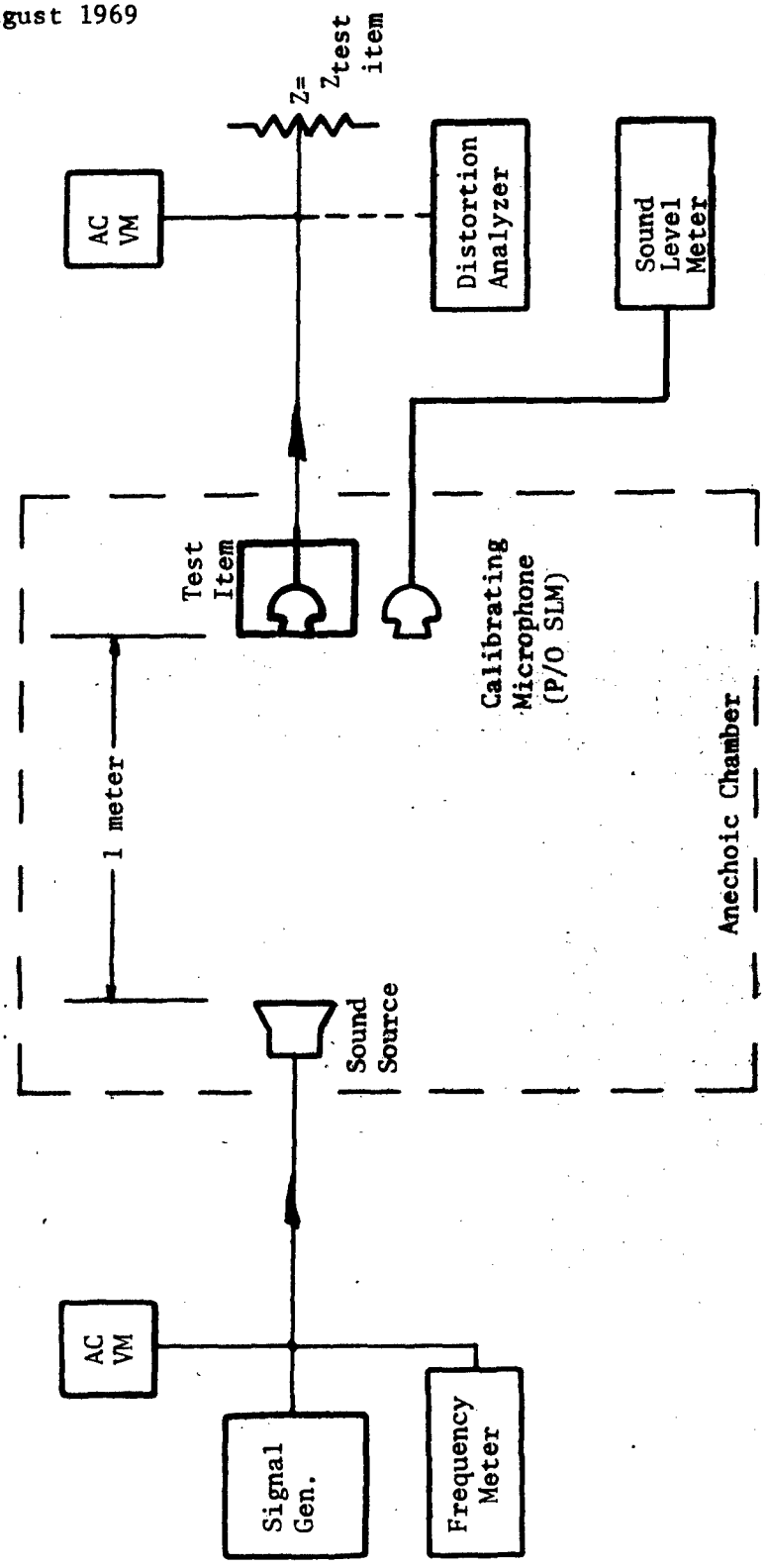


Figure 1 Transmitting Test Setup.

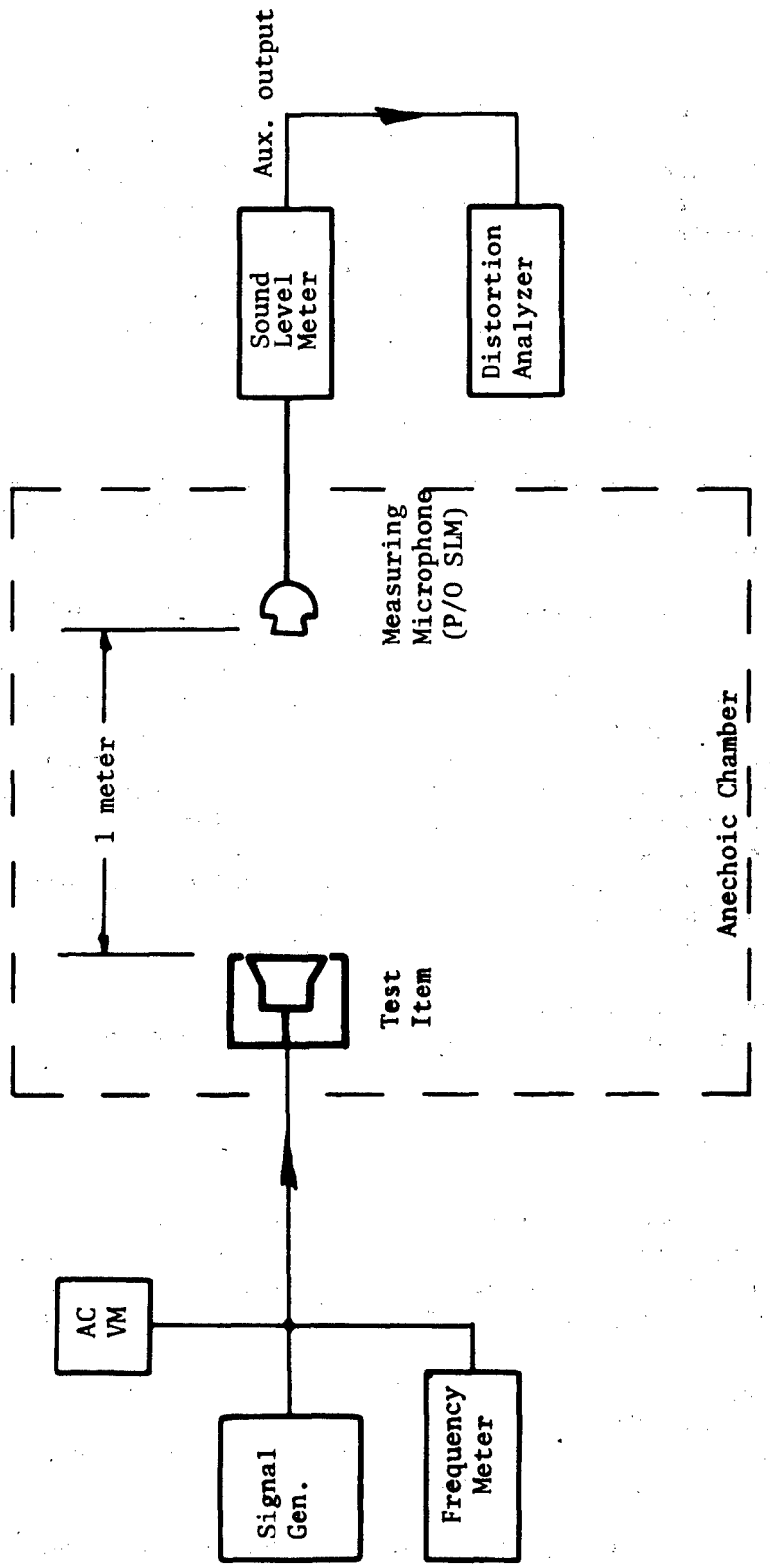


Figure 2 Receiving Test Setup.

2. Theoretically the test item and calibrating (SLM) microphone should alternately occupy the same point in space relative to the sound source. However, for practical test purpose the SLM microphone may be positioned on the test item mount as closely as possible to the test item without contact and in such a manner that the two diaphragms are in the same plane and the principal axis are convergent on the sound source. The test item "talk-listen" switch shall be locked in the "talk" position.

b. Measure the amplitude response as follows:

1) With the sound source inoperative, record the chamber ambient sound level as read on the sound level meter (SLM) in dbrap. Record the test item output signal (ambient + thermal noise) in dbm.
2) Adjust the signal generator for a 1.kHz sine wave output at a level (dbm) which will produce a sound pressure at the test item and calibrating microphone 10 db above the ambient noise level. Record the signal generator level (dbm), the SLM reading (dbrap) and the test item output level (dbm).
3) Increase the signal generator output in steps to produce sound pressure levels in increments of 10 db to a maximum of 110 dbrap (approximate) or as otherwise specified. Record the three levels as in Step b.2 above, at each step.
4) At the appropriate point in the incremental measurements of Step b.3 above, make a specific measurement at 74 dbrap (approximately 1. ubar) and record results.

NOTE: An average human speaker at a distance of one meter generates a sound pressure of about one ubar (one dyne per square centimeter).

c. Measure the frequency response as follows:

1) Adjust the frequency of the generator in half octave increments (see Table 1.) from 60 Hz to 3600 Hz, adjusting the output level at each frequency to maintain a sound pressure level of 74 dbrap at the measuring point. At each step record:

a. Signal generator frequency (Hz) and output level (dbm)
b. Test item output (dbm)
c. Sound level meter reading (74 dbrap) and the meter frequency response correction factor (+db)

NOTE: The test frequencies given in Table I have been rounded slightly from the true half-octave values for practical purposes (Reference 4. J.)

TABLE I

Preferred Test Frequencies (Hz)

60	250	1000
90	350	1400
125	500	2000
180	700	2800
		3600

d. Utilizing the distortion analyzer shown in Figure 1, measure the total distortion concurrently with frequency response (Step C. above). The total distortion (dbm) in the test item output signal shall be measured and recorded at each test frequency (Table 1.) with the test frequency suppressed within the analyzer.

e. Determine directional response (reference Figure A-2.) as follows:

1) Establish a frontal test signal of 1. kHz at a sound pressure level of 74 dbrap at the test item measuring point; test item and SLM microphone oriented as in previous tests, i.e. principal axes effectively aligned with sound source axis. Record the test item output level (dbm).
2) Maintain the signal generator output of Step e.1 above, and reposition the test item-SLM microphone in the horizontal plane to successively place the principal axis at angles (θ) of -90°, -45°, +45° and +90° to the sound source. Record the sound pressure level (dbrap) and the test item output level (dbm) at each position.
3) Repeat the procedure of Step e.2 above, with the test item placed in four angular positions (ϕ) in the vertical plane.

NOTE: The angles of sound incidence given above are arbitrary; test requirements may dictate others including a full 360° swing in each plane.

6.2.1.2 Receiving Tests

a. Arrange the item under test and measuring microphone (P/O SLM) in an anechoic chamber and connect a signal generator, frequency meter, AC

voltmeter, sound level meter, and a distortion analyzer as shown in Figure 2.

NOTE: In this configuration, only the test item shall be located on the movable mount. The measuring (SLM) microphone shall be positioned as shown with the two principal axes aligned. The test item "talk-listen" switch shall be locked in the "listen" position.

b. Measure the amplitude response as follows:

1) With the signal generator output at zero and the test item operative, record the chamber ambient sound level as in paragraph 6.2.1.1 b. (1).
2) Adjust the signal generator for a 1. kHz sine wave output at a level which the test item will reproduce as a sound having a pressure level at the measuring microphone just discernible above the ambient sound level. Record the signal generator output level (dbm).
3) Increase the signal generator output level in conveniently small increments to produce sound pressure levels increasing smoothly to approximately 130 dbrap. At each step record the signal generator output level (dbm) and the SPL (dbrap).

c. Measure the frequency response by adjusting the signal generator frequency in half-octave increments from 60 Hz to 3600 Hz (see Table 1, paragraph 6.2.1.1) at a constant nominal level throughout, e. g. 0 dbm. Record the frequency and the SPL (dbrap) at each increment.

d. Measure total distortion concurrently with the Frequency Response Test (Step C, above) utilizing the distortion analyzer as shown in Figure 2. At each test frequency, measure and record:

1) Total SLM output level (signal + distortion) in dbm.
2) Distortion only (fundamental suppressed).

e. Measure directivity essentially described for the transmitting test (paragraph 6.2.1.1, Step e.) except that the test sound signal (1 kHz at reference SPL of 74 dbrap) is emitted by the test item which shall be rotated with respect to the fixed measuring microphone. Record the sound pressure level at each test item position.

6.2.1.3 Ancillary Transducers

Handsets or headsets which are integral components used optionally in lieu of the microphone-loudspeaker to provide a privacy feature shall be tested in accordance with the applicable portions of MTP 6-2-110 or MTP 6-2-115.

6.2.2 Intelligibility Test

a. Arrange the item under test in two similar rooms which are acoustically representative of a real environment and install typical artificial noise sources, sound level meters, and a volume indicator as shown in Figure A-3.

NOTES: 1. Distances between personnel and equipment shall be as determined experimentally by the test engineer and shall be maintained throughout the tests. For example, the transmitting control can be arbitrarily set at mid-range and the receiving control set to provide a comfortable sound level agreeable to the listeners.
2. The volume indicator is provided to aid the talker in maintaining a uniform speech level. This may be a VU meter as shown and adjusted to read relative speech volume only (not true volume units) or may be the sound level meter operating in the "slow-acting" mode. The talker's speech level shall be such as to produce an approximate average sound pressure level of 74 dbrap at the test item.

b. Conduct the first test phase as follows without simulated background noise:

1) The talker shall pronounce a series of 50 key words selected from the list in the appendix. These words shall be spoken singly in the following carrier sentence: "Would you write (key word) now." This shall be read as a simple declarative sentence. The manner of speaking shall be such as to place no unnatural stress on any word. Observation of the volume indicator as the first three carrier words are spoken, will aid the talker in achieving a uniform speech level for the key word.
2) Each listener shall write, using normal spelling, only the key words on his answer sheet. If a key word is missed entirely it shall be so indicated by a dash in order to maintain the correct sequence for grading.
3) The test shall be repeated a sufficient number of times (reference MTP 3-1-002) to ensure valid test results using a different list of key words in each test.

c. Conduct the second test phase in a manner similar to the foregoing except that pre-recorded typical background sounds shall be reproduced to create representative ambient noise fields, first in Room A and then in Room B.

NOTES: 1. The class of pre-recorded sounds shall be selected by the test engineer based on test requirements and/or intended.

test item employment. These may include the sounds of equipment coolers, air conditioners, typewriters, conversation, and miscellaneous noise.

2. The number and placement of noise reproducers within a test room shall be at the discretion of the test engineer in reconstructing a realistic ambient noise field. A detailed description of the setup shall be included in the test report.
3. In the talker's room, the noise field level shall be adjusted in increments to produce speech-to-noise ratios of, for example, 20, 15, and 10 db as measured by the SLM and a different word list spoken in each condition. Listeners shall record the received words in the usual manner.

d. Repeat Step (c) above, with the noise conditions established in the listener's room instead of the talker's, using different word lists.

e. Repeat Steps (a) through (d) above, as required for test items which incorporate privacy feature handsets in addition to the microphone-loudspeaker unit.

6.2.3 Miscellaneous Tests

6.2.3.1 Signaling

a. Interconnect the signaling circuits of two test items as prescribed by the instruction manual.

b. Connect a decade resistance box in series with each circuit in turn and while operating the corresponding call key intermittently, increase the resistance until the associated far-end annunciator just operates satisfactorily. Record the resistance values (ohms) for each circuit. Observe that the common audible signal operates satisfactorily for each annunciator operation.

6.2.3.2 Crosstalk

a. Connect an impedance matching device, two AC voltmeters, and two audio oscillators to the item under test as shown in Figure 3.

b. Adjust the audio oscillators to provide a readily distinguished two-tone signal at a combined output level commensurate with the maximum test item output values derived in the amplitude response test (paragraph 6.2.1.1 b (3)).

c. Utilizing a test operator, listen for an audible signal at the loudspeaker and, if detected, record the fact and the level indicated by the AC voltmeters.

d. Test each station line circuit in turn as the "disturbed circuit" by changing connections at the terminal board and operating the station-select keys.

6.2.3.3 Vibration Test

a. Mount the test item in a manner typical of its intended use, i.e.

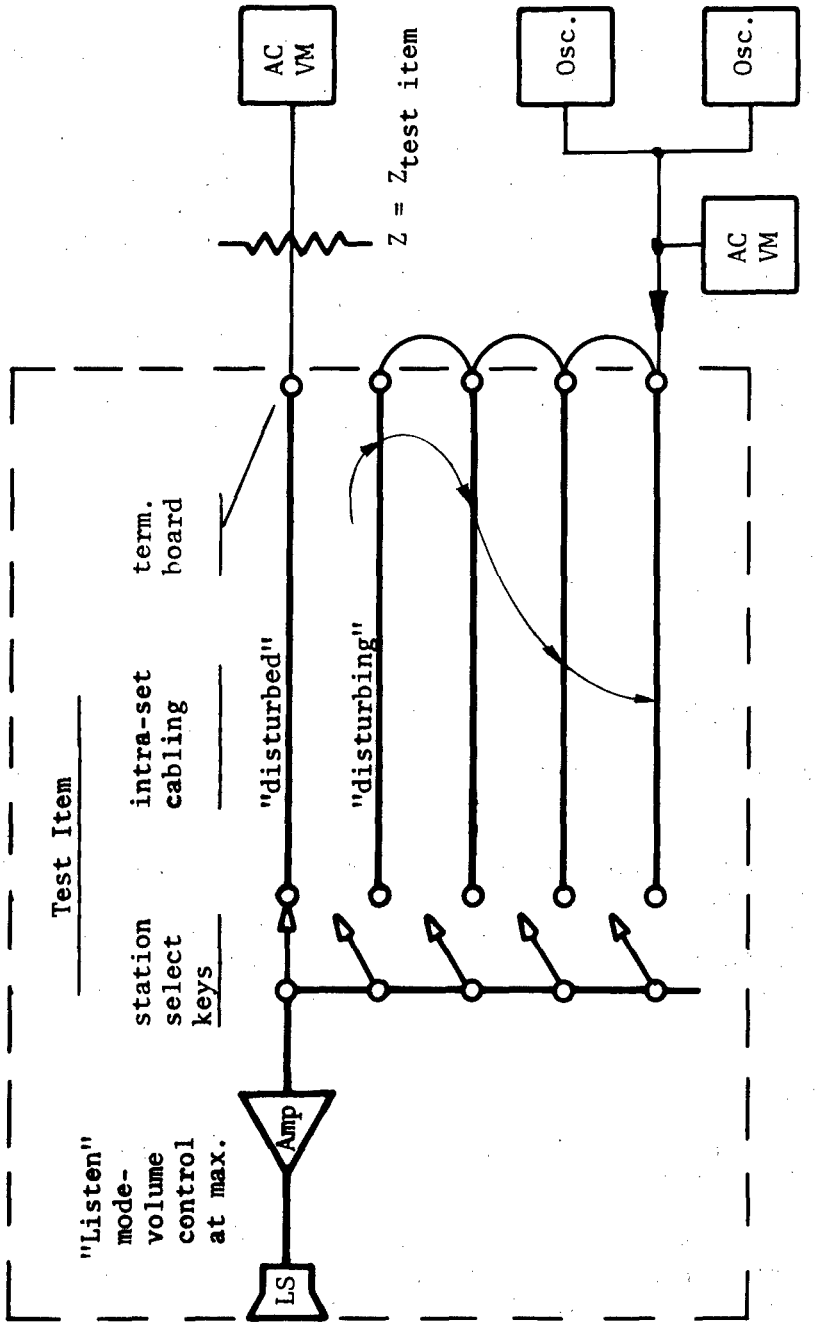


Figure 3 Crosstalk Test Setup.

on a desk, table, or wall bracket.

b. Lock the operating controls in the "talk" and full volume positions and terminate the line output with a matching impedance, an AC VT voltmeter, and a frequency meter.

c. Attach a suitable vibrator to a panel of the wall or desk in such a manner and location as to set up structural vibrations which will produce a reading (dbm) on the voltmeter. (Vibrator frequencies in the general region of 20 to 100 Hz are recommended unless otherwise directed). Record the test item output signal level (dbm) and the dominant frequency (H3).

d. Lift the test item out of contact (e.g., one or two inches) with the mounting structure while maintaining the conditions of Step (c) above. Record the output signal level (dbm).

e. Repeat Steps (a) through (d) above, varying the vibrator location, frequency and amplitude as required to obtain meaningful results.

6.2.3.4 Electromagnetic Interference Test

Subject the item under test to electromagnetic interference in accordance with the applicable sections of MIL-STD-462.

6.3 TEST DATA

6.3.1 Preparation for Test

Data to be recorded prior to testing shall include but not be limited to:

a. Nomenclature, serial number(s), manufacturer's name, and function of the item(s) under test.

b. Nomenclature, serial number, accuracy tolerances, calibration requirements, and last date calibrated of the test equipment selected for the tests.

c. Damages to the test item incurred during transit and/or manufacturing.

6.3.2 Test Conduct

Data to be recorded in addition to specific instructions listed below for each subtest shall include:

a. A block diagram of the test setup employed in each specified test. The block diagram shall identify by model and serial number, all test equipment and interconnections (cable lengths, connectors, attenuators, etc.) and indicate control and dial settings where necessary.

b. Photographs or motion pictures (black and white or color), sketches, charts, graphs, or other pictorial or graphic presentation which will support test results or conclusions.

c. An engineering logbook containing, in chronological order, pertinent remarks and observations which would aid in a subsequent analysis of the test data. This information may consist of temperatures, humidity, pressures, and other appropriate environmental data, or other description of equipment or

components, and functions and deficiencies, as well as theoretical estimations, mathematical calculations, test conditions, intermittent or catastrophic failures, test parameters, etc., that were obtained during the test.

d. Test item sample size (number of measurement repetitions).

e. Instrumentation or measurement system mean error stated accuracy.

6.3.1 Electroacoustic Characteristics

6.3.1.1 Transmitting Tests

a. Amplitude response data shall include the following, recorded in order of increasing amplitude from the ambient sound level value:

1) Signal generator output (dbm)
2) Sound pressure level (dbrap)
3) Test item output (dbm)

b. Frequency response data shall consist of the following, recorded at each frequency step:

1) Signal generator frequency (Hz)
2) Test item output (dbm)
3) SLM reading (dbrap)
4) SLM correction factor

c. Total distortion test data, i. e. distortion level (dbm) at each test frequency, may be recorded on the Frequency Response data form in an additional column.

d. Directional response test data shall be recorded under the following headings:

1) Angle of incidence θ
2) Angle of incidence ϕ
3) Sound pressure level (dbrap)
4) Test item output level (dbm)

The SLM directional characteristics, if significant, shall be included for data reduction.

6.3.1.2 Receiving Tests

a. Amplitude response data shall include the following, recorded in order of increasing amplitude from the ambient sound level value:

1) Signal generator output level (dbm)
2) Sound pressure level (dbrap)

b. Frequency response data shall include the following, recorded at

at each frequency step:

1) Signal generator frequency (Hz)
2) Sound pressure level (dbrap)

c. Total distortion test data may be incorporated in the frequency response data form and shall include the following:

1) SLM output level (dbm) i. e. test frequency and distortion.
2) Distortion only level (dbm), test frequency suppressed.

d. Directivity test data shall be recorded under the following headings:

1) Angle of incidence θ
2) Angle of incidence ϕ
3) Sound pressure level (dbrap)

6.3.2 Intelligibility Test

Test data to be derived from this test shall include the following items and information as a minimum. Normally, a complete set of data shall be compiled for each test phase or subtest, e. g. quiet environment and noisy environments.

a. A detailed description of each test room (diagrams and narrative) with emphasis on the location of equipment items and personnel in each test condition.

b. Sound pressure levels (SPL) of speech and noise under stated conditions (e. g. location of sound sources and measurement points) particularly the SPL's established to obtain specific speech-to-noise ratios.

c. The talker's word lists and correlated listener's answer sheets, identified and compiled by subtest.

6.3.3 Miscellaneous Tests

6.3.3.1 Signaling Test

Minimal test data shall consist of a tabular record of the operate and non-operate resistances (ohms) for each signaling circuit in each direction, notes on common audible signal function, and the test setup diagram. Data resulting from tests of other signaling schemes shall be comparable to the above in delineating operational margins.

6.3.3.2 Crosstalk Test

Test data shall include:

a. Descriptive test setup diagram
b. Test tone frequencies (Hz) and level (dbm)

c. Crosstalk level (dbm) measured on each station line
d. Pertinent remarks

6.3.3.3 Vibration Test

Test data shall include:

a. Detailed description of test conditions (narrative and sketch/diagram) including vibrator characteristics.
b. Test item output signal level (dbm) at average ambient room noise.
c. Signal level (dbm with vibrator operating and test item in contact).
d. Signal level (dbm) with vibrator operating and test item isolated from mounting structure.

6.3.3.4 Electromagnetic Interference Test

Test data shall be recorded as prescribed by MIL-STD-462.

6.4 DATA REDUCTION AND PRESENTATION

The test data prescribed in paragraph 6.3 shall be correlated and reduced by the most advantageous means available, employing both manual and automatic data processing methods as appropriate. Presentation of final data shall include the applicable diagrams and test description. Graphs shall be supported by the detailed data in tabular form.

6.4.1 Electroacoustic Characteristics

6.4.1.1 Transmitting Tests

a. Amplitude response data shall be presented as a graph of test item output (y axis) versus sound pressure level (x axis). The ambient and one microbar level points shall be indicated.
b. Frequency response and distortion data may be a combined graph as shown in Figure 4.
c. Directional response data shall be presented in graphic form as illustrated in Figure 5. Horizontal and vertical plane data may be plotted on one graph unless the curves conflict to a confusing extent, in which case separate graphs shall be prepared. Polar coordinate format may be used if preferred.

6.4.1.2 Receiving Tests

a. Amplitude response data shall be presented as in paragraph 6.4.1.1, Step (a), except that the test item input levels shall be shown on the y axis and measured SPL's on the x axis.
b. Frequency response and distortion data shall be presented as in paragraph 6.4.1.1, Step (b), except that measured SPL shall be plotted from the left ordinate and distortion data from the right ordinate.

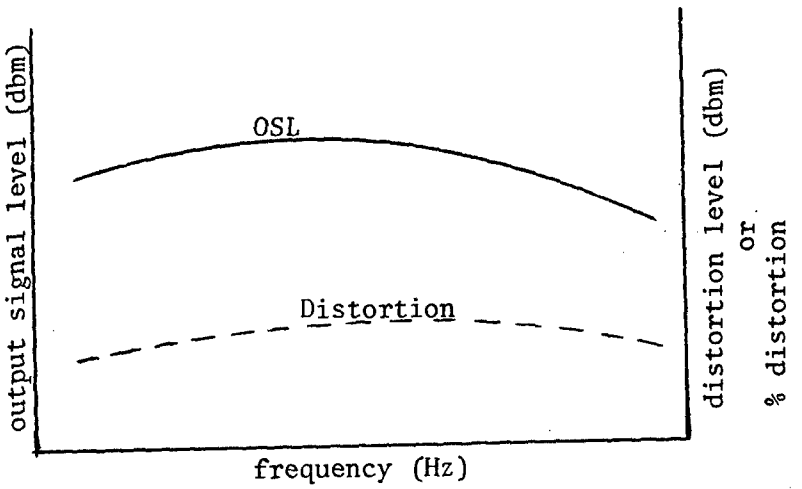


Figure 4

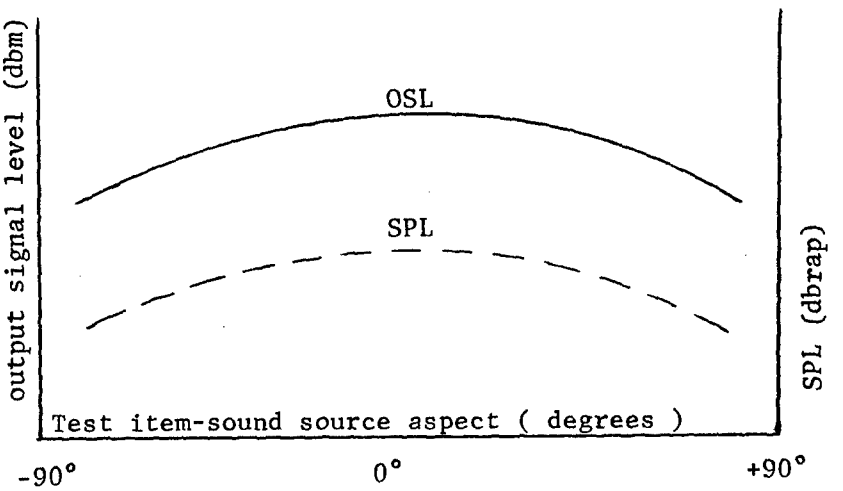


Figure 5

c. Directivity test data shall be presented as in paragraph 6.4.1.1, Step (c), except that only the measured SPL is plotted with respect to the angular positions.

6.4.2 Intelligibility Test

Listener answer sheet data shall be averaged and the articulation score (AS) computed for each word list transmission or for the total transmissions within each subtest.

$$AS = \frac{\text{total words correctly understood}}{\text{total words spoken}} \times 100$$

Data resulting from both test phases shall be plotted on a graph of

AS (y axis) versus S/N ratio. S/N ratios shall be scaled on the x axis starting with the "quiet room" S/N (first phase) at the left and progressing decrementally through the background noise S/N ratios (second phase). Separate curves shall be plotted for the Room A and Room B background noise tests.

6.4.3 Miscellaneous Tests

6.4.3.1 Signaling test data shall be presented in a manner describing the operational reliability of the subject signaling method under stated conditions. For the method exemplified in paragraph 6.2.3.1 the major data item to be presented is the maximum external circuit resistance allowable for reliable signal operation.

6.4.3.2 Crosstalk test results shall be presented as a summary of measured crosstalk levels, test zone levels, and correlated test observations.

6.4.3.3 Vibration test data shall be presented as the ratio in db of the signal level measured with the test item mounted to the level measured with the test item isolated.

Test item total output signal includes ambient room noise + air-conducted vibrator noise.

$$\text{VI (db)} = \frac{\text{total output level, test item mounted (dbm)}}{\text{total output level, test item isolated (dbm)}}$$

6.4.3.4 Electromagnetic Interference Test

Test results shall be presented as prescribed by MIL-STD-462.

GLOSSARY

An extensive list of definitions and terms is beyond the scope of this document, however, the items listed herein are deemed worthy of explanation.

Acoustic Environment: The environment simulating free-field conditions to the extent that the inverse-pressure versus distance law should hold within plus or minus 1 db at all frequencies at which measurements are made. Ambient noise should not affect the measurements to an extent greater than plus or minus 1 db.

dbrap: Decibels Reference Acoustic Pressure; see Sound Pressure Level.

Free-Field: A sound-wave field devoid of obstacles causing reflection, refraction, or diffraction.

Sound Pressure: The rapid variation of atmospheric pressure around a steady-state value caused by a sound. Since it is an alternating quantity, "sound pressure" usually refers to the rms value expressed in microbars. One microbar equals one dyne per square centimeter.

Sound Pressure Level: The rms pressure of sound expressed in decibels above a reference value of 2×10^{-4} microbar which is approximately the threshold of hearing at 1000 Hz. Mathematically, if p is the rms pressure of a given sound and p_o is the reference value, then the sound pressure level =

$$20 \log_{10} \frac{p}{p_o} .$$

APPENDIX A

INTERCOMMUNICATION SETS

1. INTRODUCTION

Engineering tests of prototype intercommunication sets or commercial sets under consideration for Army procurement are usually performed to determine if the intercommunication set's technical characteristics and performance are in conformance with current military requirements. Additionally, in the case of prototype equipment, these measurements make possible timely recommendations for in-production changes to correct any problems uncovered. The establishment of universal test procedures and the acquiring of accurate data from such tests greatly aids in evaluating the performance of the equipment from the standpoint of service suitability.

The following paragraphs describe some of the engineering tests required to evaluate the performance of such items.

2. ELECTROACOUSTIC CHARACTERISTICS

This test series will determine the significant response characteristics of the test item under the following conditions/provisions:

a. The test item is defined as a single intercommunication set consisting of a reciprocal transducer (microphone-speaker unit) and the associated amplifier functioning together as one entity, first as a microphone (transmitting) and second, as a loudspeaker (receiving) as shown graphically in Figure A-1. Since most intercommunication sets incorporate an uncalibrated, unindexed volume (amplifier gain) control, tests will be performed with the control at the maximum setting, unless otherwise specified.

b. The test environment is an anechoic chamber or a comparable free-field acoustic environment (see glossary). All equipment is located outside the test chamber except the test item, the sound source and the sound meter microphone. The test item is placed in the approximate center of the chamber on a vibration-absorbent mount which is movable in the horizontal and vertical planes to permit orienting the test item principal axis with respect to the sound source and measuring microphone. Figure A-2 illustrates the principal axis and measurement planes.

c. Sound pressure measurements are made with a standard sound level meter (SLM) calibrated to read rms sound-pressure level (SPL) in decibels (dbrap) above a reference sound pressure of .0002 microbar at a stated frequency (see glossary). If the selected sound level meter incorporates different frequency weighting networks, the "flat response" network is used. The overall free-field response-frequency characteristics of the sound level meter and the directional characteristics of the integral microphone are then plotted on graphs.

NOTE: As an aid in relating sound pressure in microbars and sound pressure level in dbrap to commonly known sounds, a table of approximate values is given in this appendix.

3. INTELLIGIBILITY TEST

The intelligibility test is an accepted standard method for determining the speech transmission quality of a communication system in a realistic environment. A comprehensive treatment of the method is given in Reference 4. K.

Briefly, the method of measurement as presented herein requires a setup comparable to that of Figure A-3 and involves a selected person, the "talker", enunciating a number of phonetically balanced works (see attached list) in front of a transmitting test item which is connected to a remotely located receiving test item. At the receiving set one or more selected "listeners" write down the words as they hear and understand them.

The intelligibility characteristic of the system under test is then rated by the percentage of correctly understood words, commonly termed the articulation score or AS.

Environments selected for the test may consist of tactical shelters/vans, average office areas, or preferably two similar rooms which are acoustically representative of a real environment except for typical background noise.

4. MISCELLANEOUS TESTS

4.1 SIGNALING

This test is applicable to those types of intercommunication sets which provide a selective station signaling feature in a multi-station system as opposed to voice-call signaling. Different signaling methods may be encountered in test item design, however, the most common form is comparable to a simple door-bell circuit multiplied by the number of stations involved. This example is selected for descriptive purposes and may be adapted to other signaling techniques.

A single one-way signaling circuit enabling one station to call another specific station consists of a push-button or key at the calling station and a visual indicating device (annunciator or light) at the called station, the two items interconnected by a wire circuit separate from the voice circuit; power is supplied from a common source. The physical arrangement of any one station set equipped to communicate with similar stations usually consists of a bank of key-annunciator units, one for each station, with the annunciators designed to operate a common audible signal (buzzer) for attracting the user's attention to an incoming call.

Satisfactory audible signal operation is determined by measuring the resistance values for go and no-go operation of the circuit.

4.2 CROSSTALK

This test is applicable only to multi-line test items and is generally required to determine if voice-frequency coupling exists between station lines within the test item, i. e. excluding external system wiring/cabling. Normally, it is not necessary to measure the exact level of crosstalk, mainly whether or not it is detectable from nominal operating signal levels. Conventional crosstalk measurement methods may be modified in several ways to provide a relatively simple "worst case" check test.

Crosstalk is determined by inserting a two-tone signal from audio oscillators into the "disturbed" circuit and measuring the response.

4.3 VIBRATION

This test determines the adequacy of the test item's acoustic insulation from extraneous vibrations which may be transmitted through the mounting structure to the microphone thus potentially degrading speech quality.

The effect of vibration is determined by mounting the test item in a manner typical of its intended use, subjecting the mounting to selected vibrations, and measuring the response of the item under test.

4.4 ELECTROMAGNETIC INTERFERENCE TEST

A comprehensive method of determining the objectionable radiation or emission caused by operation of the test item is described in MIL-STD-462, Reference 4.A.

5. SUPPLEMENTARY INFORMATION

The table of relative sounds and levels mentioned in paragraph 2.c. is given on page A-5. It is presented only as an aid in orienting test personnel in the field of sound measurement. The values listed are only indicative of sound "loudness" at a single frequency of about 1000 Hz. Loudness of a sound varies with frequency and is generally expressed in other terms such as "phons"; as a measurable quantity requiring special equipment it is not used in this document.

Derivation of sound pressure level (dbrap) is given as:

$$SPL = 20 \log_{10} \frac{\text{measured pressure (ubars)}}{\text{reference pressure (.0002 ubar)}}$$

An example of the phonetically-balanced (PB) word list prescribed for the Intelligibility Test (paragraph 6.2.2) is presented on page A-5. Additional approved word lists should be used as necessary to avoid invalid test results due to repetition. Reference 4. K. presents a number of standard word lists.

Representative Phonetically Balanced (PB) Word List

PB-50 List 3

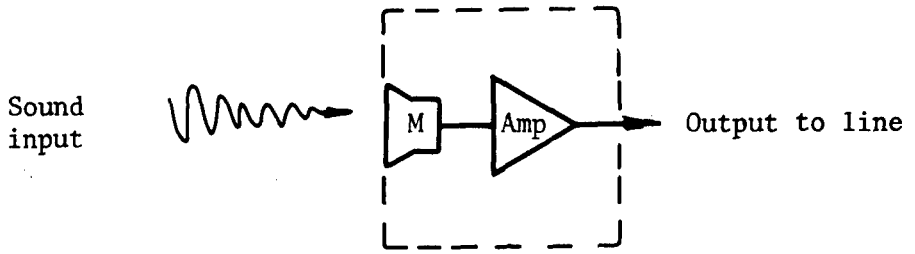
1. why
2. turf
3. gnaw
4. drop
5. jam
6. flush
7. rouse
8. neck
9. sob
10. trip
11. dill
12. thrash
13. dig
14. rate
15. far
16. check
17. air
18. bead
19. sped
20. cast
21. class
22. lush
23. shout
24. bald
25. cape
26. size
27. wedge
28. deck
29. hurl
30. wharf
31. leave
32. crave
33. vow
34. law
35. stag
36. oak
37. nest
38. sit
39. crime
40. muck
41. fame
42. take
43. who
44. toil
45. path
46. pulse
47. fig
48. barb
49. please
50. ache

PB-50 List 4

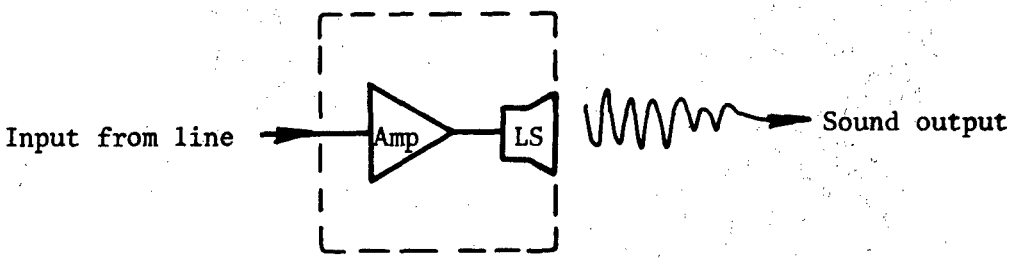
1. float
2. sage
3. cloak
4. race
5. tick
6. touch
7. hot
8. pod
9. frown
10. rack
11. bus
12. blonde
13. pert
14. shed
15. kite
16. raw
17. hiss
18. fin
19. scab
20. how
21. strap
22. slap
23. pinch
24. or
25. starve
26. new
27. rut
28. neat
29. dodge
30. sketch
31. merge
32. bath
33. court
34. oils
35. shin
36. peck
37. beast
38. heed
39. eel
40. move
41. earn
42. budge
43. sour
44. rave
45. bee
46. bush
47. test
48. hatch
49. course
50. dupe

RELATIONSHIP OF COMMON SOUNDS AND MEASUREMENT PARAMETERS

Common Sound Sources	Sound Pressure (ubars) (dynes/cm^2)	Sound Pressure Level (dbrap)
Reference Acoustic Pressure	.0002	0
Threshold of hearing	.0003	3
	.0006	10
	.0020	20
Average whisper at 4 feet	.0036	25
Quiet room	.0063	30
	.0200	40
Average room	.0632	50
	.2000	60
Average speech at 1 meter	1.000	74
Noisy street	3.556	85
Average speech at telephone microphone diaphragm	20.00	100
Average speech at lips	63.24	110
Aircraft 20' from propeller-) Jet aircraft-)	200.00	120
Threshold of pain	2000.00	140



a. Test item as microphone (transmitting condition).



b. Test item as loudspeaker (receiving condition).

Figure A-1 Basic Test Item Transmission Configurations.

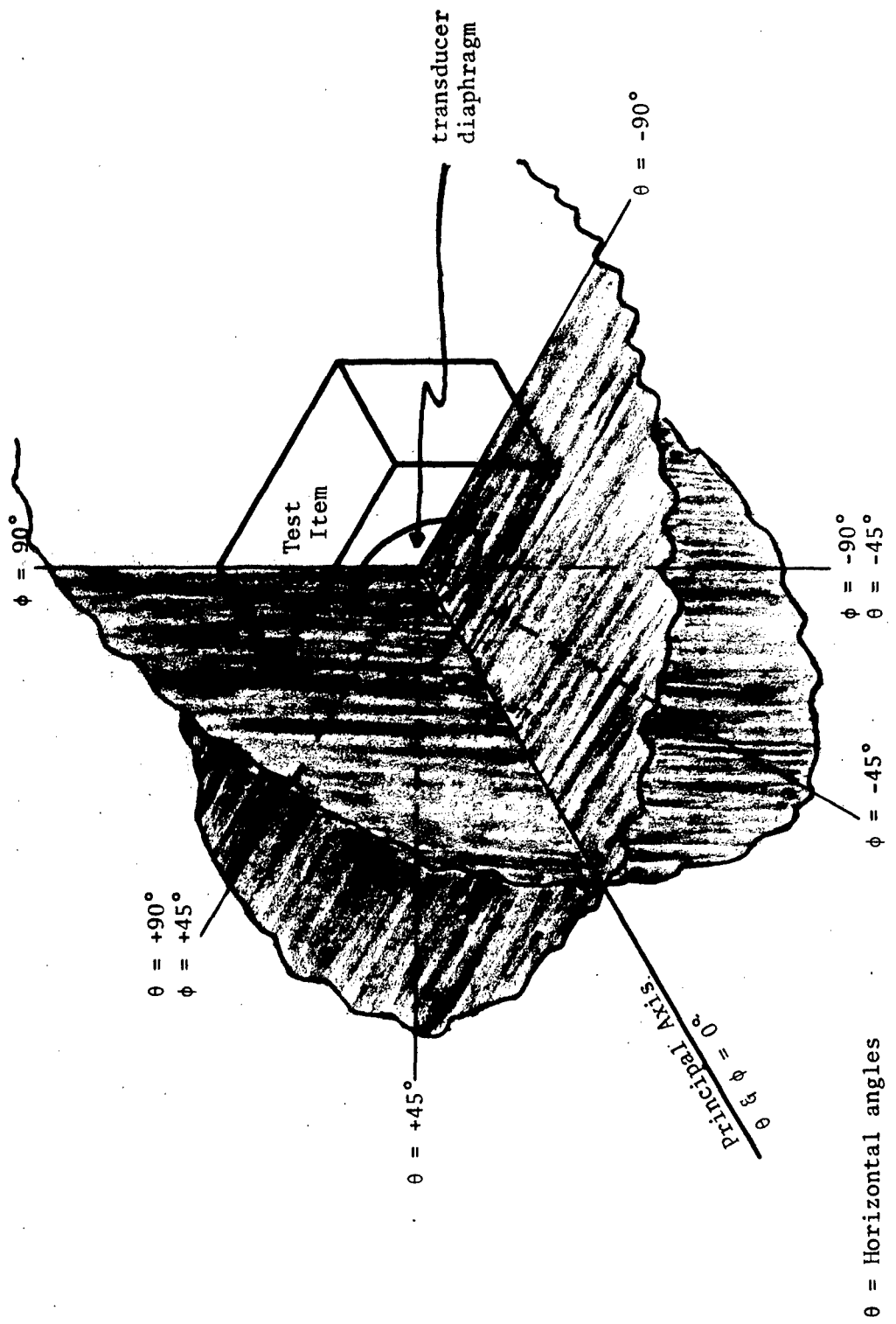
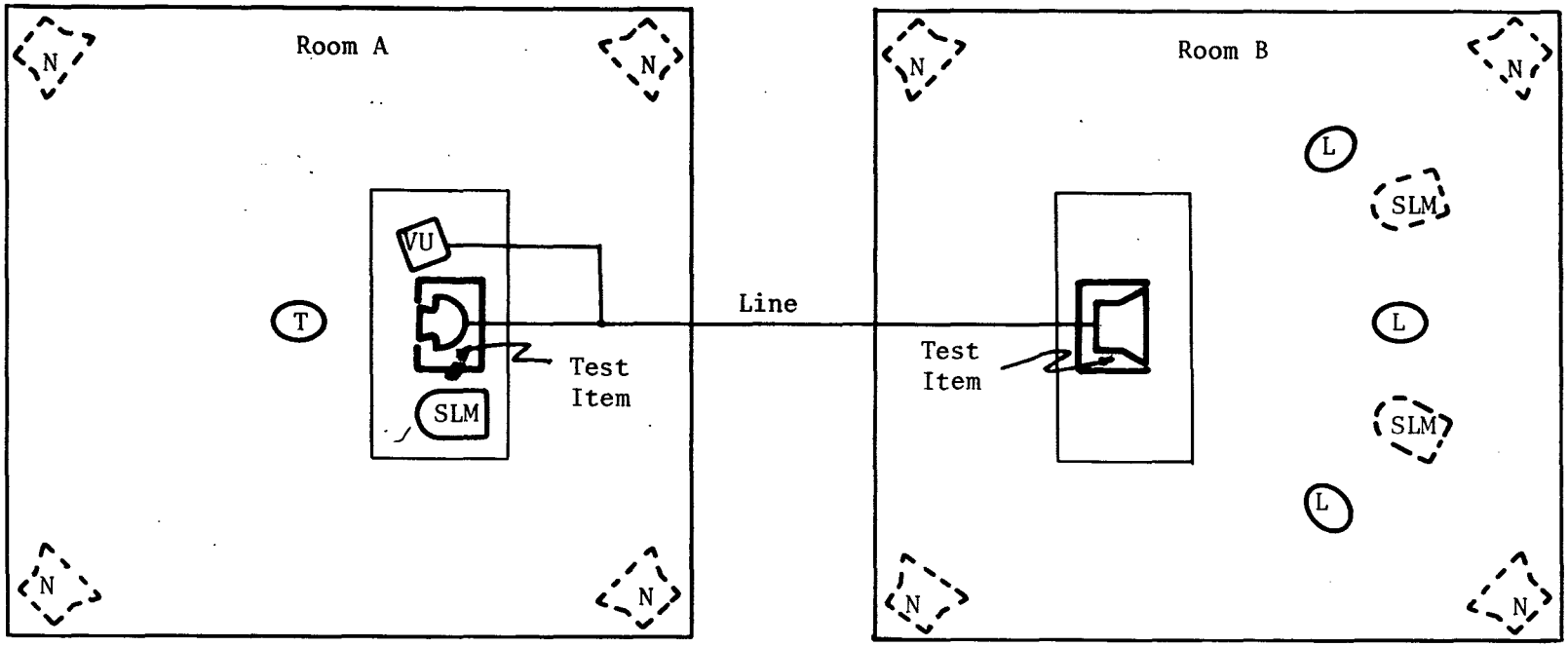


Figure A-2 Illustration of Principal Axis and Planes of Measurement.



Legend

T = Talker
L = Listeners
N = Noise sources-optional locations
SLM = Sound Level Meter
VU = Volume indicator

Figure A-3 Intelligibility Test Setup.